# THE ROLE OF THE UNIVERSITIES IN THE ECONOMIC DEVELOPMENT OF BRITISH COLUMBIA

A Report By

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June, 1987

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## SUMMARY

**The new economy of British Columbia reflects structural changes in the world economy.** For prosperity, it is no longer possible to rely solely on demand growth, productive efficiencies and strong prices for basic commodities. British Columbia, like many others the world over, must be better prepared for an era of rapid technological change, strong foreign competition, world wide perspectives in marketing, the production of complex products for sophisticated consumers, and the necessity for adding value to the products of industry. To be prepared means using a broad spectrum of human resources for a competitive edge, rather than simply as a factor in production, ensuring provision for rapidly changing skill requirements, and fostering the growth of new businesses based on new technologies, new skills and imaginative leadership.

For British Columbia, the new economy must feature:

- Efficient, highly-productive and technologically-advanced resource-based industries.
- Sophisticated, internationally-oriented service industries, capitalizing on opportunities for tourism, trade, and transportation.
- Diversification of business into a wide variety of activities in such fields as high technology, value-added manufacturing, cultural and knowledge-based industries, financial services, transportation and distribution.
- A highly educated and adaptable human resource, a pool of talent to comprise a sophisticated and innovative work force, able to respond to societal change.

**The universities make major contributions to the economy** through their various programs of education,

enriching the quality of the human capital resources that are essential to spirited development. In every field of study, universities strive to develop a capacity for critical thinking, and an awareness of how much there is to know. Growth in the economy and growth in employment are closely related to the level of education of the provincial workforce. The universities occupy a special place in the educational system as the teachers of teachers. Advanced education will be critical to the aspiration to win in the tough competition of the marketplace. The quality of education, particularly advanced education, is now and will be a major determinant in attracting business enterprises.

The universities must collaborate with government, industry and labor in responding to changing social needs and expanding world knowledge, and must work together in targeting development on:

- Key new fields of advanced education to ensure competence in emerging areas of discovery, such as microelectronics, computer science, biotechnology, materials science, health sciences, and other areas in which the province must have the capacity to participate.

- Advanced education for the next generation of managers and entrepreneurs to lead the commercial thrusts of the new economy in the resource-based, service-oriented, and diversified industries of the future.

- Subject areas of particular significance to the economic strategies of the province, such as studies related to the language, literature and culture, and social, economic legal and political structures of Pacific Rim countries.

- Innovative programs of graduate study that enable specialization in subject areas relevant to current areas of provincial economic growth or economic concern.

- Maintenance of the highest standards of training for the various professions that are critical for the health, social services and economic development of the province.

- Expansion of cooperative advanced education programs with all industrial sectors.

- Expansion of programs of continuing education and professional retraining in recognition that 80% of those who will be in the professional workforce in 2001 are already adults today, and that half of their professional training will be out of date within five years of graduation.

**The research activities of the universities have a major impact on the provincial economy.** They generate more than 60 per cent of the research in the province. By virtue of their basic and applied research, the universities are the province's major connections to the knowledge networks of the world, and the prime sources of highly specialized advice and facilities. They provide a forum for thoughtful consideration of the impact of a fast-changing society on cultural and ethical values. Their discoveries and inventions are the inspiration for new business enterprises. They excel in the import and export of technology, know-how and insight for economic benefit. Their resources of talent and facilities are magnets for investment by industry. They are major actors in the processes of technology transfer. To enhance these roles, the universities:

- Invest in the conduct of world-class research in a wide array of disciplines.

- Collaborate with government, industry and labor in the strategic planning of research thrusts.

- Emphasize research in areas of relevance to the provincial economy, in such areas as international trade, economic and policy analysis, finance, and marketing.

- Emphasize research in areas relevant to the advancement of the resource-based industries of the province, such as forestry-related biotechnology and techniques of mineral exploration.
- Exploit opportunities for research in new fields of technology that lead to new industries in British Columbia, such as microelectronics and computer-based systems.
- Collaborate in the development of joint university research facilities such as TRIUMF and WCUMBS.
- Enhance mechanisms for multidisciplinary, multi-institutional approaches to applied research problems, encouraging collaboration of Faculties and Universities.
- Foster cooperation with industry in research enterprises, assisting industry by the provision of advice, information and facilities.
- Encourage the process of development of commercial applications of research findings through patenting and licensing.
- Facilitate the formation of spin-off companies based on university research, providing both prototype facilities and management advice.

**The universities are flagships of the provincial image.** Through the dispersion of graduates from home and abroad, they build a web of alumni who occupy positions of influence. Through participation in programs of teaching and research in foreign countries, the universities build familiarity and confidence in British Columbia. The role of universities as ambassadors for the province, with all that is implied for the economy, is enhanced by:

- Expansion of activities that are related to building international contacts, particularly in the Pacific Rim countries.
- Increased involvement in exchange agreements with foreign universities.
- Participation in consortia for the delivery of educational programs in developing countries.
- Expansion of research activities funded through international development agencies.

**The universities have a direct impact on the provincial economy.** Research grants and contracts bring more than $100 million into the province each year. Out-of-province students contribute at least $20 million. Visitors from all parts of the world come to the universities for scholarly conferences and make significant contributions to revenue from tourism. From these and other sources, universities are directly responsible for an injection of at least $150 million annually into the British Columbia economy from out-of-province sources.

**The universities are an invaluable provincial resource** in support of the economic, social and cultural goals of the province. Their prime purpose has been, and will be, to provide opportunities for British Columbians to obtain the education they need to best serve society, teaching not only what is known, but the attitude to what is not yet known. The universities will play a major role in the new economy of the future, a role in keeping with the greater maturity and economic and social complexity of the province of British Columbia.

## FOREWORD

This discussion paper was prompted by a request from the Honourable Stanley B. Hagen, Minister of Advanced Education and Job Training, to the presidents of the three provincially-funded universities. In his words, "...we are all in agreement that the role our universities have to play in the economic development of the province is significant indeed. British Columbia faces unique challenges in responding to fundamental market and technological changes.... I am anxious to explore with you possible research and teaching initiatives which you may be able to undertake together. I would ask that you consult with your colleagues in the other universities in this regard in order to prepare a discussion paper for my consideration entitled, *The Role of Universities in the Economic Development of British Columbia.*"

This report has been prepared by representatives of the three universities, T.W. Calvert of Simon Fraser University, J.E. Currie of the University of Victoria and P.A. Larkin of the University of British Columbia, with the assistance and encouragement of Assistant Deputy Minister, Dr. James Rae. The assistance of Jane Gaskell, Jonathan Wisenthal, Malcolm McMillan and Larry Sproul in preparing material for various parts of the document, and of Jeffrey Berryman and Helen Hahn in its production, is gratefully acknowledged.

## THE NEW ECONOMY

British Columbia's universities have a strong tradition of service in the development of the province. By sharpening minds to think critically, by presenting the challenge of appreciating how much there is to know, by teaching the teachers, by providing the training for the professions, the universities have developed the capacities of the human resources of the province. The impact of the universities on the social and economic fabric of the province is without question. Why, then, should we now ask, "What is the role of the universities in the provincial economy?"

The answer is twofold: the province has grown up and the world is changing.

In the past century, British Columbia has come a long way from the pioneering era of resource development. "Lumbering" has become a vertically integrated forest industry that extracts a sustainable harvest from the forests of the province and produces a wide range of wood products. Rivers have been harnessed for hydroelectric power, enhanced for production of salmon, diverted for irrigation and constrained from flooding. Similar stories of development characterize all of the province's rich endowment of natural resources. Much remains to develop, but with much less prospect of quick or easy economic gain.

At the same time, and in consequence of the utilization of the resource base, British Columbia has witnessed a growth in population, largely centred in the Lower Mainland, southern Vancouver Island and a few cities in the interior, a population largely dependent on servicing the resource industries.

Other service industries rely on the role of British Columbia as the western gateway of Canada, providing the machineries of trade and finance with the countries of the Pacific Rim. Still other service industries flourish on the strength of the province's reputation as a place to holiday, retire, or to set up

shop in a creative enterprise. And then there are service industries that service the service industries, and so on.

These well known stages of development to maturity have been accompanied by comparable changes in other parts of the world. Many of the industries in the province have interests in similar kinds of enterprise abroad; conversely, many foreign companies have interests in British Columbia. Increasingly, the province's industries are tied to national and international networks of commerce. Our provincial economy is not only more complicated than it used to be, it is also much more a part of a global economy.

Throughout the same period of development of the British Columbia and world economies there were profound advances in science and technology. It is sufficient to recall that 40 years ago there were no television sets and no computers; 30 years ago there were no contact lenses or commercial jet airplanes; 20 years ago there were no microwave ovens or laser discs. Almost every business has been challenged by changing technology. Resource based industries must be more efficient and productive. Manufacturing industries must automate and innovate. Small businesses can now exploit dozens of opportunities in the application of new technologies. Knowing how to do things has become a big business. To succeed in the next century it will be necessary to *know* and to *excel.*

Although the process of change has been continuous, it is widely perceived that now is the critical time for a push to what has been called the "new economy", with its attendant challenge to universities throughout North America.[1] [2] British Columbia's development has been late by comparison with that of other parts of the continent, but the need for a new economic perspective is no less urgent. It has been clearly

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[1] American Association of State Colleges and Universities. 1986. The Higher Education-Economic Development Connection: Emerging roles for public colleges and universities in a changing economy. A.A.S.C.U. and U.S. Dept. of Commerce.

[2] American Association of State Colleges and Universities. 1986. Issues in Higher Education and Economic Development. A.A.S.C.U. and U.S. Dept. of Commerce.

stated in public documents[3] that for prosperity it is no longer possible to rely solely on demand growth, productive efficiencies and strong prices for basic commodities. British Columbia, like many others the world over, must be better prepared for an era of rapid technological change, strong foreign competition, worldwide perspectives in marketing, the production of complex products for sophisticated consumers, and the necessity for adding value to the products of industry. To be prepared means using a broad spectrum of human resources for a competitive edge, rather than simply as a factor in production, ensuring provision for rapidly changing skill requirements, and fostering the growth of new businesses based on new technologies, new skills and imaginative leadership.

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[3] Honourable William N. Vander Zalm and Honourable Grace M. McCarthy. 1986. The New Economy. Presentation at the Pacific Centre for Trade, Commerce and Travel, September 29, 1986.

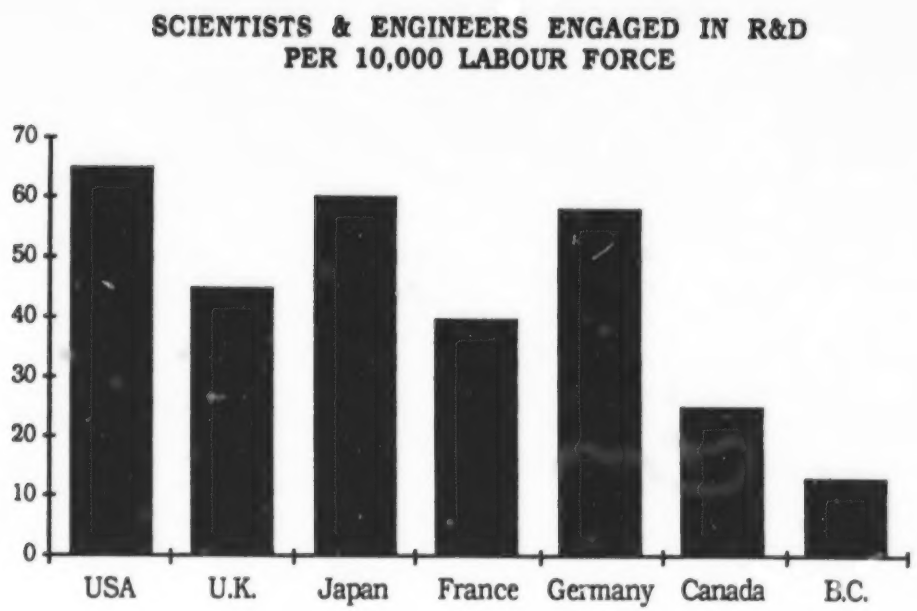


*Figure 1. British Columbia has a small proportion of scientists and engineers in its work force. The universities have a major role to play in producing highly qualified graduates. (Source: Conference Board Statistics Canada, CSB Estimates.)*

## HIGHER EDUCATION AND ECONOMIC GROWTH

The higher education system of British Columbia has grown with the province and contributed to its economy. Prior to World War II, the University of British Columbia and Victoria College were the only provincially-funded institutions of higher learning. With the rapid growth of the province and its population in the years following the war, it became necessary to enlarge the system to cope with the demand. The Macdonald report of 1962 was a turning point, which led to the establishment of Simon Fraser University, the transformation of Victoria College to the University of Victoria, and the establishment of a number of regional Colleges.

The whole of the system he envisaged is now in place. The University of Victoria and Simon Fraser University are well on the way to being "comprehensive universities", a network of community and regional colleges offers a wide variety of programs, and there is an Open Learning Authority devoted to distance education. The universities have become significant contributors to the national and international networks of higher education.

There can be little doubt that the whole system of higher education has made a major contribution to the economy of the province. Although there have been no detailed studies for British Columbia, there is an extensive literature concerning other regions that is aimed at quantifying the contribution of education to economic growth through increasing labour productivity and through research and development.[4,5] A recent study by Dale Jorgenson of Harvard University[6] estimates that for the U.S. in the period 1948 to 1973, labour accounted for 28 per cent of economic growth. Of that 28 per

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[4] Denison, E.F. 1985. Trends in American Growth, 1929-1982. Brookings Institute, Washington, D.C.

[5] Carnevale, A. 1983. Human Capital: A high yield corporate investment. American Society for Training and Development.

[6] Jorgenson, D. 1983. The contribution of education to U.S. economic growth: 1948-1973. National Bureau of Economic Research, Washington, D.C.

cent, almost one half (45 per cent) was due to an increase in the quality (not quantity) of labour; and of that increase, two-thirds was due to formal education. OECD studies estimate that increased labour quality on average accounted for ten per cent of the growth in labour productivity in OECD countries in the past two decades.[7] In the words of Carnevale[5] "Educated, healthy, trained and spirited people are the ultimate source of human growth."

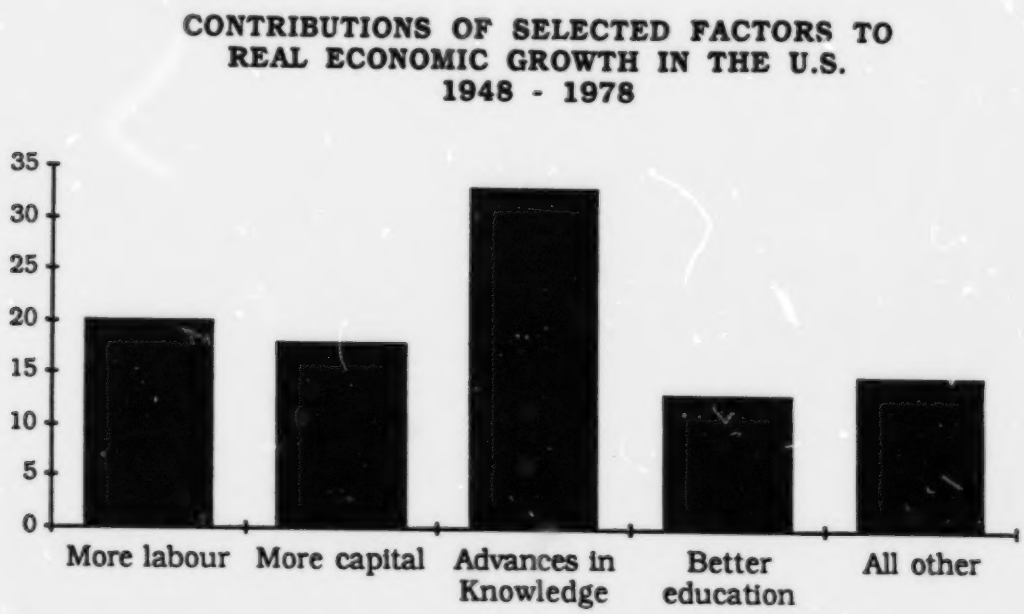


*Figure 2. Education is a major contributor to economic growth. (Source: Denison(1974), Kendrick (1981))*

[7] Organization for Economic Cooperation and Development. 1986.Productivity in Industry: Prospects.

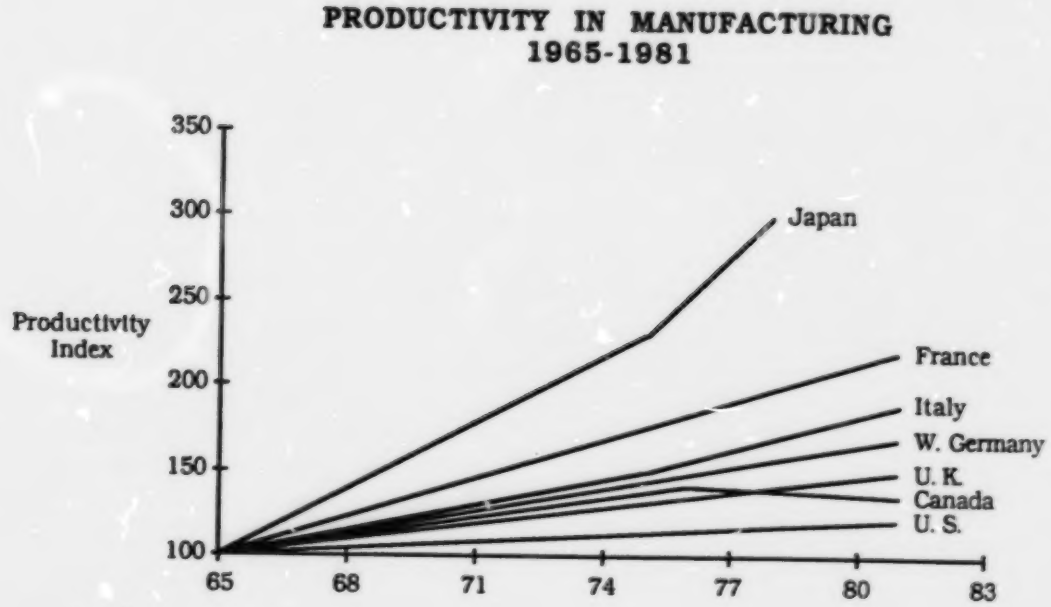


*Figure 3. Increased labour quality is an important factor in increasing labour productivity. (Source: OECD)*

The economic benefits of education in general, and of higher education in particular, are most apparent at times of intense competition. As the economies of the industrialized, developed countries become increasingly dependent on information and technology, the importance of higher education is increasingly appreciated. An important study by Kern and Schuman[8] documents the increasing role of advanced skills and human resources in new modes of production. For those of the developed countries that are only marginally major economies, such as Canada, higher education is critical to the aspiration to compete effectively in a world economy, especially when many parts of the country have little or no tradition of

[8] Kern, H. and N. Schuman. 1984. Das ende der arbeitsteilung? Verlag C.H. Beck, Munich.

industrialization.[9] In the words of the CATA report,[10] "Nations that lag in the new international race for technology leadership will have increasing difficulty creating income and employment opportunities for their citizens."

Greater investment in higher education is widely seen as a key to development of the Canadian economy in the next few decades. There is a direct relationship between levels of education and levels of unemployment[11] and levels of income.[12] Canadian and United States research demonstrates that the main determinant for location or relocation of a company is the availability of highly skilled labour.[13] Good universities attract high technology companies that seek graduates knowledgeable at the state-of-the-art level.[14] The White House Science Council Panel on the Health of U.S. Colleges and Universities summarized its report[15] with the opening paragraph,

> "The health of U.S. society is uniquely coupled to that of its universities. To a greater degree than any other country, this nation looks to its universities both for new knowledge and for young trained minds prepared to use it effectively. But just at a time when

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[9] Science Council of Canada. 1987. Winning in a World Economy: Canadian Universities and Economic Renewal. Ottawa.

[10] Canadian Advanced Technology Association. 1987. The Report of the National Technology Policy Round Table.

[11] Forget, C. 1986. Commission of Inquiry on Unemployment Insurance: Report. Supply and Services Canada, Ottawa.

[12] Organization for Economic Cooperation and Development. 1985. The Role of the Public Sector: Causes and Consequences of the Growth of Government. OECD Economic Studies No. 4. Paris.

[13] Whybrow, J. 1984. Labour and the Location of High Technology Industry: some prospects for British Columbia. Ministry of Universities, Science and Communications, Victoria, B.C.

[14] The Conference Board. 1986. Locating corporate R&D Facilities. Conference Board Report 892, 1986. Washington, D.C.

[15] White House Science Council. 1986. A Renewed Partnership: An examination of federal government-university-industry interactions in U.S. research in higher education in science and engineering. Report of the Panel on the Health of U.S. Colleges and Universities. Office of Science and Technology Policy, Executive Office of the President, Washington, D.C.

much is expected of our universities, after more than a decade of retrenchment and belt tightening, they find themselves with obsolete equipment, aging facilities, and growing shortages of both faculty members and students in many important fields."

*Figure 4. Unemployment rate is lower for those with higher levels of education. (Source: Statistics Canada. The Labour Force. December, 1986)*

Much the same can be said of British Columbia universities, except that their period of retrenchment came a bit later. Over the two year period between the 1984-85 and 1986-87 fiscal years, the average increase in higher education expenditures in the United States was 14 per cent. The increase for one quarter of the states was over 20 per cent.[16] For British Columbia, over the same period the increase in total funding from the provincial government to the three universities was

[16] Hines, Edward R. 1987. Appropriations of state tax funds for operating expenses for higher education 1986-87. National Ass'n. of State Universities and Land Grant Colleges. Illinois State University, Normal, Illinois.

5.6 per cent. British Columbia has to do some catching up to be competitive.

The provincial government has clearly stated the need to strengthen and diversify the provincial economy and the intention to take full advantage of the resources represented by the province's three universities. The following sections of this paper give an indication of those resources.

## THE CONTRIBUTION OF THE UNIVERSITIES: TEACHING AND SERVICE

Anyone who goes for advice or assistance to an engineer, lawyer, doctor, dentist or pharmacist, is likely to be reassured to see a diploma on the office wall that testifies to the completion of a university degree. It is expected that universities will give degrees only to those who are qualified, thereby providing the quality control for entry into all the professional fields both traditional and new. The universities are expected to be the teachers of the teachers, the trainers of the wide array of specialists of modern society, and the providers of continuing education in the professions. These are essential roles in modern society that universities undertake in concert with each other both nationally and internationally. As the institutions in which the members of the professions receive their first accreditation, the universities play a major role in the provincial economy.

It is not so easy to appreciate that university education is much more than a series of programs to prepare people for particular positions in society. Regardless of the subject, whether it is human physiology, Japanese history, waste treatment engineering, or microbiology, the aim of the university is to give the student sufficient understanding to appreciate both the extent and complexity of human knowledge. With that understanding there also comes an appreciation of how to think efficiently and how to form one's own opinion on a subject. Anyone who knows a great deal about any subject knows the special feeling that goes with knowing what is not known. A university education is not the only way to get to know a great deal about a subject, but it is an efficient way of getting there.

So what is the connection to the economy? The connection is the importance of having citizens who can think clearly and independently about the many issues of our times. We live in an age of rapid change and shifting values. It is important that

as a society we have the greatest possible number of thoughtful people who have been educated to the limits of their abilities. That is the best way to ensure adaptability, orderly economic growth and social stability.

It is equally important that a university offer the widest variety of program that is consistent with ensuring depth in each. One never knows which branch of knowledge will suddenly be important to society. A large literature attests to the social values of breadth as well as depth in the range of educational opportunities.

Universities give more to their students than a series of courses that make up a program. The associations that students have with students in other programs provide an ancillary education into the complexities of society and a respect for all branches of knowledge. The mixing with students from all parts of the province, from other parts of Canada, and from other parts of the world, builds a web of friendship and common experience that persists for a lifetime.

Universities provide education for many more than the students in the regular sessions. There are extensive programs of distance education for those who find it inconvenient or too expensive to attend lectures on campus. There are extensive programs of continuing education open to the public which cover a very broad range of subjects. The total number of people involved in all the programs of the universities is three times their official "enrolment" which is the number in attendance at the regular sessions.

Universities give even more to the larger community they serve. Lectures, plays, concerts, symposia and other such activities that are not connected with course offerings are often open to the public at no charge. Faculty members make themselves available to the media, to government and to community groups for lectures, discussions, commissions, task forces, reviews and day-to-day advice and comment. In essence, faculty members are a community resource of great economic and social value.

Connected with this role is the notion of the university as a community amenity. People are attracted to areas where they

perceive a certain "quality of life." Tourism is strongly influenced by cultural attractions such as musical and theatrical events and exhibitions of art. The natural geographic advantages of the province should be complemented by richness of the cultural environment.

There is not much question that universities with strong social, cultural, scientific and professional programs and faculty enrich the life of the community. It is an enhancement that takes place not only in the lecture hall and the research lab but whenever and wherever university personnel take on roles of community leadership, and in their day-to-day contacts convey the excitement of ongoing enquiry into all aspects of life.

Throughout all of their activities, university professors are constantly engaged in learning as much as in teaching. The day-to-day interaction with students, the difficulties of explaining, the necessity for keeping abreast of new knowledge, all contribute to the discovery of new areas of research which in turn may lead to new economic and social applications.

## THE CONTRIBUTION OF THE UNIVERSITIES: RESEARCH AND FACILITIES

Research and scholarly studies are intertwined with teaching as the primary activities of universities. Most research at universities is supported by competitively awarded grants and contracts from government agencies, private foundations, and industrial corporations. The better a university is at doing research, the greater external funding it attracts.

The three provincial universities attracted in total almost $80 million in external funding for research in fiscal 1985/86, more than 90 per cent of which came from outside the province. Adding the indirect costs of research--the infrastructure costs of space, facilities, personnel and administration which come from the provincial government operating grant--the total expenditure on research now exceeds $120 million per year.

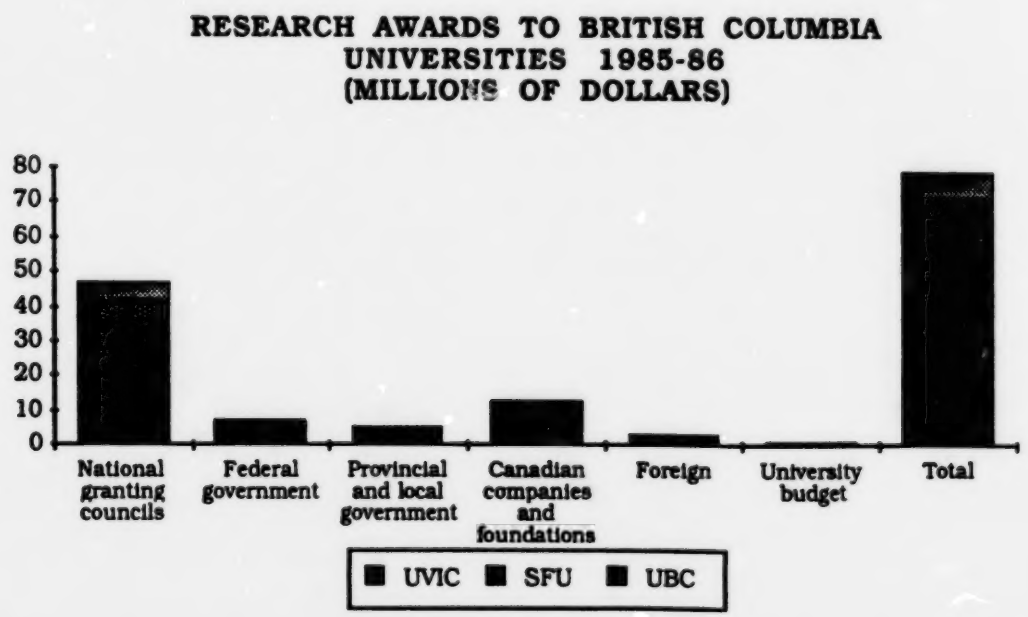


*Figure 5. The universities attract substantial external funds for research. (Source: U.C.B.C)*

On the university campuses and adjacent Discovery Parks, other research enterprises spend an additional $60 million per year. (The major enterprises are TRIUMF, B.C. Research, PAPRICAN, Agriculture Canada, Forintek, and the Biomedical Research Centre at UBC; and Microtel Pacific Research at Simon Fraser University, and the Bamfield Marine Station on Vancouver Island.

More than 60 per cent of all the research conducted in British Columbia takes place on the campuses of the three universities. The total expenditure of close to $200 million per year is in itself a very significant contribution to the provincial economy, especially when it is kept in mind that more than $100 million comes from sources external to the province.

The range of research and scholarly activities is representative of a very wide spectrum of subjects. The contacts of faculty members with colleagues elsewhere in Canada and around the world make the universities the province's major connections to contemporary knowledge. Much of the expertise at universities is unique in the province because it is more specialized or advanced than that which any single company could afford on a continuing basis.

The same may be said of many specialized facilities of the universities, the prime example being the libraries, especially that at UBC which serves as the major provincial resource library: if you can't get it anywhere else, try UBC. Indeed, in many subjects, UBC is the resource library of Western Canada. It is the second largest library in Canada, with a collection valued at $265 million.

The universities also house a large number of sophisticated pieces of equipment which are much too expensive to be justified in the budget of a company that has only limited need. Mass spectrometers, x-ray diffraction and x-ray fluorescence utilities, nuclear magnetic resonance spectroscopes, electron microscopes, liquid chromatographs, and many other such devices, are commonly made available to local industry on a cost-recovery basis.

In brief, the community at large has access to informed people, excellent library and computing facilities, and sophisticated

equipment. The universities are well placed to serve the economic purposes of the private sector, and government.

Aside from the money and investment they attract, and the advice and facilities they can offer, the universities are major sources of discovery, invention and innovation. As the pace of science and technology has quickened (scientific knowiedge now doubles every fifteen years; there are more scientists alive today than all those who have ever lived) the gap between discovery and application has shortened. Today, the nation with the best research is the nation most likely to succeed. It is against this background that the universities have taken major strides in the past five years in the transfer of technology to the market place.

Although the best technology transfer goes out of the university in the form of graduates, a great deal of technology transfer also takes place through the day-to-day interactions of university professors with other members of the community.

Commercialization of the results of research takes place either through licensing technology to existing companies, or the formation of new companies. Over the past five years, the universities have had over 100 patent disclosures from faculty and staff. Only some of these disclosures have led to patents, and only some have led to licensing agreements, but the success rate is impressive.

University-Industry Liaison Offices have been supported since 1985 by provincial and federal governments through the Science and Technology ERDA agreement. The Offices have been a major stimulant to patenting and licensing arrangements, and to the expansion of industrial research contract activity.

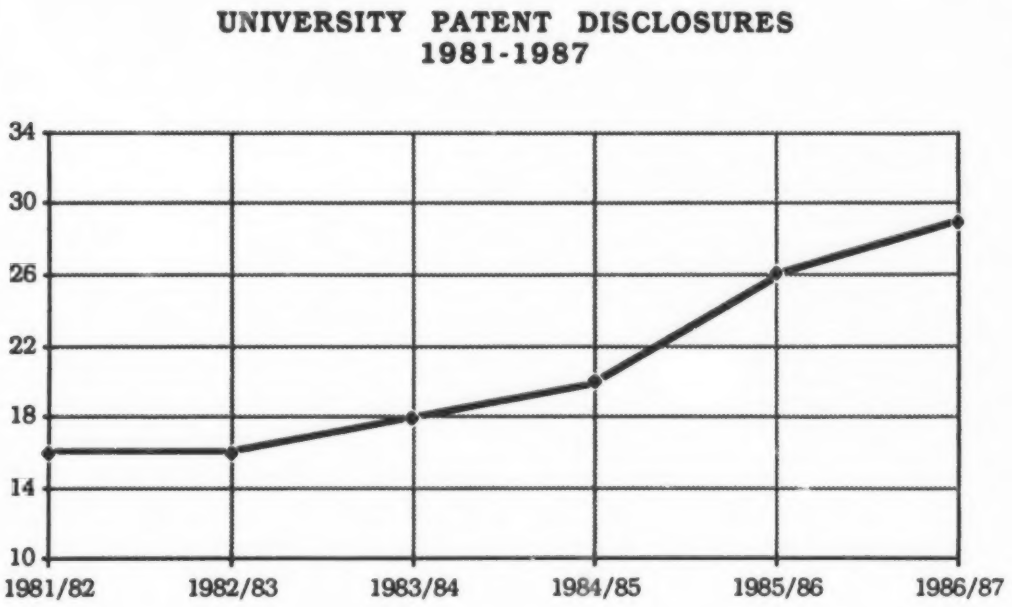


*Figure 6. Patent disclosures at the three universities have increased substantially over the past five years.*

Spin-off companies are those that owe their origin, directly or indirectly, to developments at a university. They may be formed by students or by members of faculty and staff who have left the university to go into a business based on a university invention or know-how or, more commonly, to start a business based solely on the expertise they have gained by their association with the university. At present, UBC recognizes 52 successful spin-off companies that have been established in the last fifteen years, SFU 25, and UVIC 20. In aggregate, these companies directly employ more than 1650 staff and, in 1985, had sales in excess of $170 million.

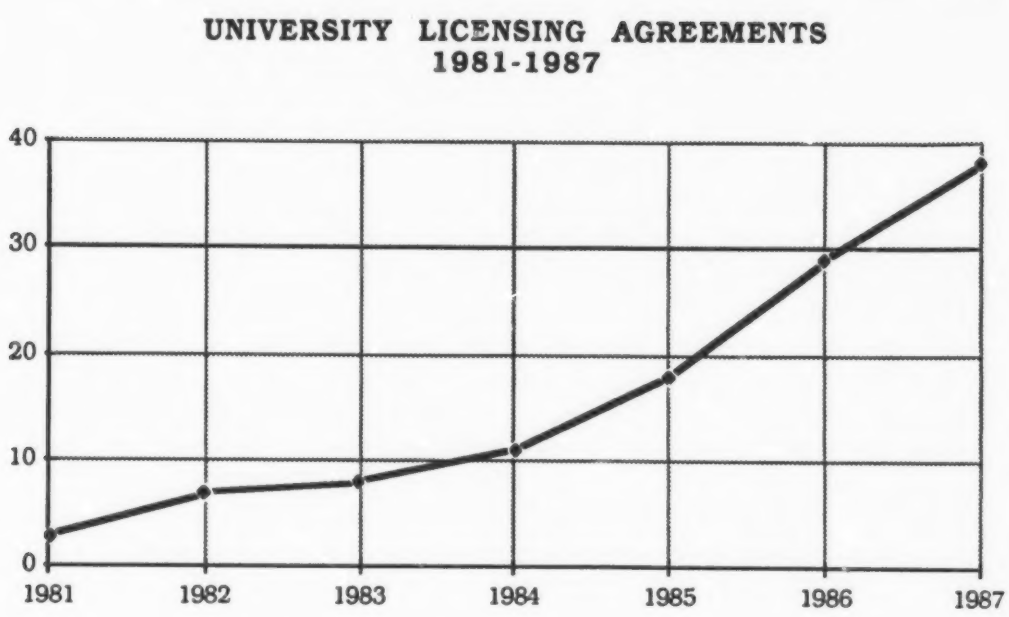


*Figure 7. Licensing agreements with industrial concerns are an important way of taking university inventions and know-how to the market. There has been a large increase in agreements at the three universities in the past five years.*

The whole of this research activity is a magnet for investment by industry in British Columbia, partly because it implies sources of consultation and collaboration; partly because it promises a source of highly qualified manpower; and partly because it signals a well developed intellectual neighbourhood where employees would like to live. The universities constitute a constellation of research strengths that has and will continue to sustain and build the provincial economy.

There are seven points to be kept in mind for the future if the universities are to make a maximum contribution to the provincial economy through research. First, they must strive to achieve world-class strength in a wide array of disciplines. It is difficult to guess which field of basic research will suddenly open up a whole new area of applied research and technology.

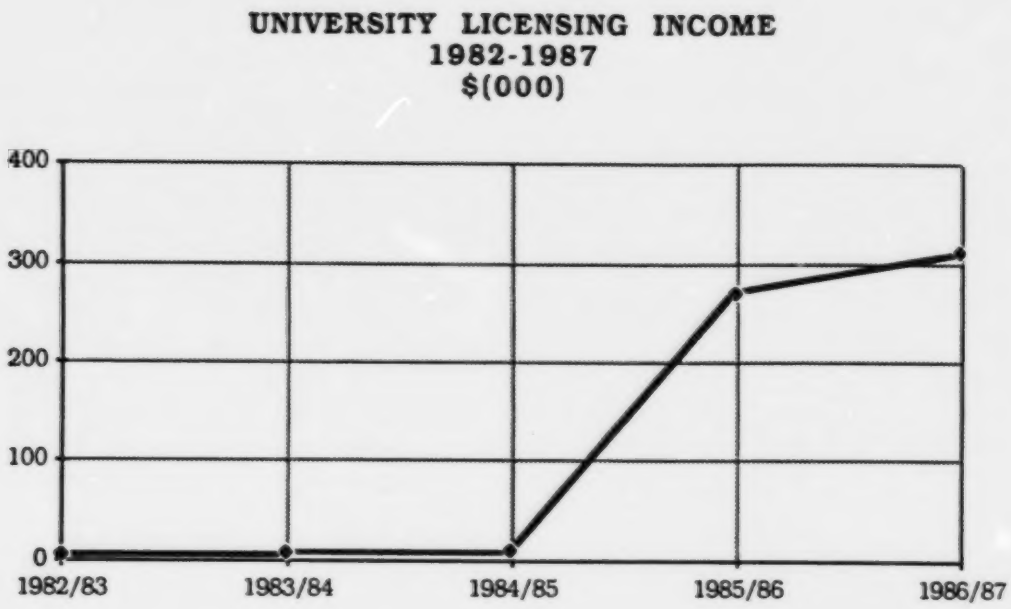


*Figure 8. Revenue from licensing agreements has dramatically increased over the past five years at the three universities.*

A good recent example is the science of superconducting, which has exploded in the last few months as a major area for extraordinarily valuable commercial applications, not the least of which is the prospect of long distance transmission of electricity with negligible loss. Fortunately, British Columbia universities have several experts in the field and are well placed to be in the race. Six months ago most of those experts would not have been thought of as a resource of relevance to the provincial economy. Strength in a wide array of basic research disciplines will be crucial to the ability to take advantage of the myriad of discoveries that mark the rapid progress of science today.

The second point is the importance of joint consultation with government, industry and labor in the strategic planning of research thrusts. Canada lags well behind other industrialized nations in spending on research and development (R&D). Our per capita scientific and technological manpower base and our R&D expenditures as a percentage of gross national product are at half the level of the competition. The trade balance in technology-intensive products, and the balance of receipts and payments for patents, licences and technical know-how, are low in comparison to those of other countries. The current trend is toward increased differences between Canada and its major competitors.[17] As one of the provinces that lags behind the leading Canadian provinces in these several indices, British Columbia faces major challenges in the years ahead, for which a good response is closer collaboration in research planning by the universities, government, industry and labor.

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[17] Organization for Economic Cooperation and Development. 1986. OECD Science and Technology Indicators. No. 2: R&D, Incentives and Competitiveness. Paris.

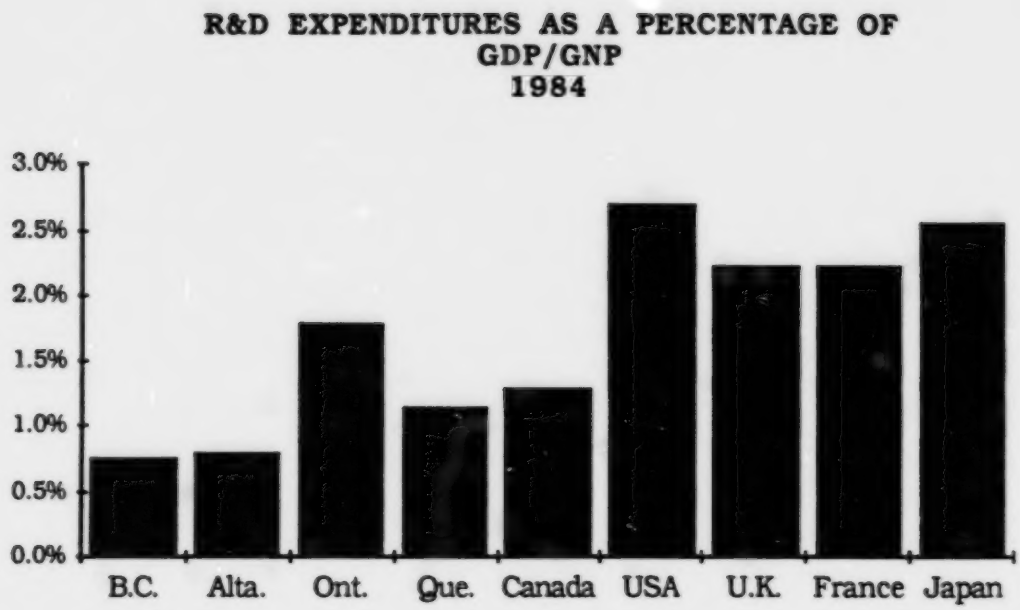


*Figure 9. Canada, and particularly British Columbia, needs to spend more on R&D to keep up with those with whom it hopes to compete. The Universities must be major actors in the increased efforts. (Source: Statistics Canada Conference Board)*

Third, is the necessity to emphasize research in areas of particular relevance to the provincial economy. If we aspire to be a significant factor in Pacific Rim trade and commerce, it behooves us to become knowledgeable by doing research in the appropriate fields.

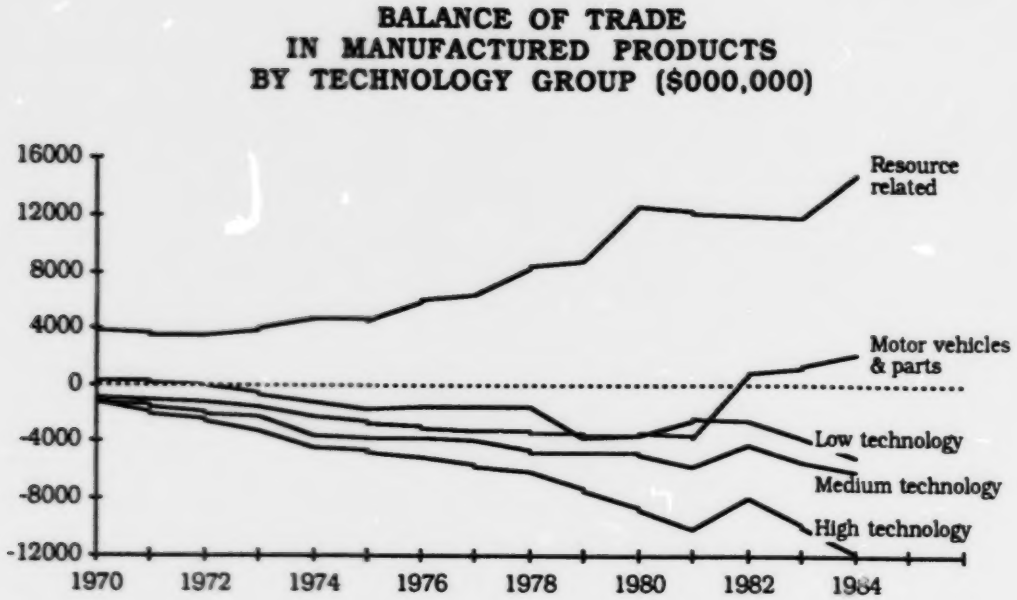


*Figure 10. The Canadian trade balance in technology-intensive products can be improved by technology transfer from the universities. (Source: Statistics Canada. Technology and Trade Statistics, Part 1.)*

Fourth, there should be strong emphasis on research that is relevant to the continued advancement of the resource industries (forestry, mining, agriculture, fisheries) that will continue to be mainstays of the economy. This is an area of research endeavour for which close collaboration with government, industry and labor is particularly important.

Fifth, the universities should be quick to exploit opportunities for research in fields of technology that could lead to new industries in British Columbia. It is naive to expect that the province will become a world leader across the whole field of, say, microelectronics, or computer-based systems, or biotechnology, but there are niches in those fields for which we

happen to have advantages that could be exploited to make significant contributions to the economy.

Sixth, is the necessity for collaboration among university Faculties, among universities, and among universities, government and industry. There are two compelling reasons for collaboration. First, it is too expensive if, for example, each Faculty at each university has its own cyclotron; or if both government and universities maintain high seas research vessels; or if industry, government and universities each maintain extensive research libraries. The same is true of personnel. It makes little sense if each institution recruits new personnel without adequate knowledge of the capabilities at other institutions. A current example is the Advanced Systems Institute, which has been established to coordinate the research among the three British Columbia universities and local industry in the field of microelectronics, computing systems and robotics.

For some fields of research, where there is need for some depth of expertise, it is prudent to coordinate on a regional or even a national basis. For example, the Canadian Institute for Advanced Research is actively encouraging collaboration among Canadian universities and industry in the field of artificial intelligence, a field in which the aggregate Canadian effort is still very small by international standards. For some kinds of contemporary science and technology, Canada can only become involved through international collaboration. The recent decision to participate in the United States space station and the long standing Canadian participation in particle physics through TRIUMF are good examples.

The second reason for collaboration among the various research sectors is the nature of the problems to which research is to be addressed. In the pursuit of basic research, the state of current knowledge poses the problem: for example, what are the properties of substances that will bind two surfaces together? In applied research the problem is posed by current practices in what is often called "the real world": for example, can you make a non- toxic glue that will bind fillings to teeth? For both kinds of research, but particularly for applied research, the combination of the strengths of different

specialities and perspectives is often critical to success. Similarly, for many challenging social problems it is essential to have contributions from several disciplines and institutions.

Seventh in the considerations for research are the necessities for encouraging the commercial application of research findings through patenting and licensing and the formation of spin-off companies. As the Science Council of Canada has observed, the "resources of the university are needed to help revitalize mature industries and generate the product ideas needed to create new ones. Canada's future prosperity increasingly depends on designing effective ways to integrate the university and the marketplace".[18] To maintain a competitive edge in technology, it is essential to put in place the linkages in the chain of research and development that extends from discovery to commercial application. The linkages may then be used to foster both the push of technology from its point of discovery and its pull from the marketplace.

Universities have long been both producers of the personnel for the linkages, and important contributors to the processes of innovation. Today, with the pressures to shorten the time between discovery and application, universities are increasingly becoming the crucial link in the innovation chain.

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[18] Science Council of Canada. 1987. Winning in a world economy. Canadian Universities Economic Renewal. Ottawa.

## INTERNATIONAL DIMENSIONS

In recent years it has become apparent that in their own self interest, and in the interest of the province, universities should expand their international scope.

The enrolment of students from other countries has been low at the undergraduate level, but more substantial at the graduate level. Foreign students come from a large number of countries (over 70 at B.C. universities) with about equal proportions from the developed countries (United States, United Kingdom, Europe, Australia and New Zealand, Singapore, Korea and Japan), and from the developing countries (China and India head the list, and there are many countries represented by a small number of students). Is this the "right mix"?[19]

Students from *developed* countries are participants in the international exchange mechanisms that have long been seen as a useful way of broadening experience. Forty years ago, universities in other places were often much better than those in Canada, so Canada had much more to gain than to lose from sending students abroad, provided, of course, that the students returned to Canada. The same is true today, but for the reason that in any particular field of research, some other university in some other part of the world is likely to be good enough that it would pay our students to go there to further their careers. By the same token, it pays others to come to British Columbia universities.

The economic advantages to Canada, and more particularly to British Columbia, of having foreign students from *developing* countries are more long term and, in some respects, less tangible. It may be difficult to demonstrate that because the university has a global reputation for, say, biotechnology, a foreign investor was influenced to hire a British Columbia

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[19] Canadian Bureau for International Education. 1981. The Right Mix: The report of the Commission on Foreign Student Policy. Ottawa.

consulting firm. It may be impossible to discover whether the fact that the Deputy Minister of Trade in Singapore took his M.B.A. degree at Simon Fraser University had anything to do with the signing of a trade agreement, or whether it was because the Canadian Trade Attaché spoke excellent Chinese, which he learned at UBC. But it is just these sorts of intangibles that might be called "the human relations context" that could prove critical in the long term to British Columbia's role in the Pacific Rim. It is worth remembering that a large number of foreign student graduates work as professionals in key positions of influence throughout the world.

It is also difficult to quantify the effect on students from our own province of rubbing shoulders with students from other parts of the world. No one would question that it is a valuable added dimension to a university education, or that it could ultimately have some economic benefit for the province, but putting a dollar figure on that kind of experience is next to impossible.

Although all of the economic benefits of having foreign students at our universities are hard to quantify, it is useful to note that a recent submission to the Senate Committee on National Finance estimated that foreign students spend $345 million annually in Canada and the cost to Canada is $62 million.[20] A second feature of international activity is the linkage with universities abroad which facilitates exchanges of students and faculty members, and the undertaking of joint research projects. Some of these linkages are formalized with agreements at the university level, others involve only a single Faculty or Department and its counterpart abroad.

Either type of linkage is virtually mandatory for the participation in research projects funded by such agencies as the Canadian International Development Agency (CIDA), the International Development Research Centre (IDRC), or projects of the World Bank, or agencies of the United Nations.

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[20] Canadian Bureau of International Education 1986. Cost-Benefit analysis of foreign students in Canada. A submission to the Standing Senate Committee on National Finance (March 1986).

Many of these projects are concerned with the delivery of educational services overseas, a role in which the universities have a great deal to offer as participants in consortia organized for the purpose. Conversely, the universities may undertake intensive programs of training for foreign students who are brought to British Columbia. There are problems in both kinds of enterprise and plans to "market educational services on an international basis"[21] will warrant careful study.

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[21] Opening Speech of The Honourable Robert B. Rogers, Lieutenant Governor, on opening the First Session of the Thirty-fourth Parliament of the Province of British Columbia, March 9, 1987.

## DIRECT ECONOMIC IMPACTS

Several studies, mainly in the United States, have measured the immediate local economic impact of expenditures by educational institutions. The University of Victoria,[22] the University of Alberta,[23] and the University of Manitoba[24] have carried out studies of this kind.

These studies invariably demonstrate that returns far exceed investment. The usual components are:

- spending from incomes by faculty and staff (i.e., disposable income, personal taxes);
- non-university expenditures by full-time students;
- direct local spending by the university (i.e., capital and operating goods and services), and employment that this creates;
- the spending of out-of-province students and visitors to campus (estimated separately);
- income from funding from outside the province;
- "multiplier" effects of the above on the local economy.

Relatively intangible economic impact is realized through community and cultural development and the resources made available to the community. Studies of this kind are useful in indicating that universities create a substantial amount of local economic activity, but the key question is, how much do

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[22] The University of Victoria. 1978. The economic impact of The University of Victoria. Victoria, B.C.

[23] The University of Alberta. 1980. The economic impact of the University of Alberta on the economy of the Province of Alberta. Edmonton, Alberta.

[24] Falconer, T.G. 1983. Direct economic impact of the University of Manitoba on the Manitoba economy, 1982-83. Winnipeg, Manitoba.

the universities bring in to the province from external sources?

For British Columbia, grants and contracts from sources external to the province are a substantial direct contribution to the provincial economy (over $100 million last year). Although there has been no detailed study in British Columbia, it is conservatively estimated that foreign students presently contribute at least $20 million annually to the provincial economy. Expenditures of visitors to the universities are also sizeable, though again no detailed statistics are available. An example may illustrate: during Expo, the University of British Columbia hosted 171 national or international conferences and bedded a total of 300,000 people for a night in the University residences. That was an exceptional summer, with over twice the usual activity. Nevertheless, even the average year represents a large economic plus for the province.

Adding up these and other sources of income suggests that the universities are directly responsible for an injection of at least $150 million into the province each year. It also supports the argument that universities have a significant impact on local economies, each dollar of continuing expenditure resulting in an increase in income for the local economy (a multiplier) of 2.5 to 3.5 dollars. On that basis, the universities annually generate nearly half a billion dollars of economic activity from sources of funds external to the province.

## A CONCLUDING COMMENT

There is a rapidly developing recognition in North America that universities should have new priorities that are more in accord with regional and national priorities.[25] The driving social forces are, first, the accelerating rate of innovation based on scientific and technological discoveries that lead more rapidly to new products, new modes of communication, and new economic conditions; and, second, the increasing pace of life as communications shrink the world. British Columbia is not alone in proposing a new economy and in proposing to better harness the universities in pursuit of the provincial cause.

In certain respects, British Columbia is better placed than some. The universities of the province have grown to be very good by international standards, and they have a strong tradition of public service. They constitute an immensely valuable provincial resource of people and facilities.

There are many ways in which the universities have changed and will continue to change in response to the economy of the times. Advances in knowledge are invariably reflected in the never ending invisible evolution of courses of instruction. The same is true of research. At a university, to do research means to try to discover something that *nobody* knew before. In consequence, there are never-ending revisions in the problems to which research is addressed. In response to major new developments in the whole field of knowledge, there is always a fresh crop of proposals for whole new programs of instruction and major expansions in new fields of research. There is no shortage of information as to what is going on in the world and no shortage of ideas about what to do about it. The difficult decisions are: which of the new proposals should be

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[25] Lynton, Ernest A. and Sandra E. Elman. 1987. New priorities for the Universities: Meeting society's needs for applied knowledge and competent individuals. Jossey-Bass: San Francisco.

implemented and which of the old activities should be curtailed?

The difficulty in part stems from the length of time it takes to complete a university program. It takes four years for a Bachelor's degree and two or more for a Master's or an advanced professional qualification. A doctorate in a specialized research field (which is more or less an apprenticeship) usually adds at least three more years. Thus, to produce precisely the "right" number of the "right kind" of graduates means anticipating the market four to nine years in advance. Mistakes could be very costly to both the students and the provincial economy.

Fortunately, the market is not entirely unpredictable, for there are patterns of demography and of social and economic development that are readily perceived. The students can assess the market too, not only when they first enrol, but along the way, and they can modify their programs accordingly. The demand for particular courses is a common stimulant to recruit new faculty in particular subject areas. Thus, there are some built-in mechanisms that help relate the output of graduates to the requirements of the market place.

But perhaps most important is that a good university education should make a graduate who is adaptable, who can think clearly, who has a capacity for self expression, and who addresses the unknown with curiosity and rigor.

Another source of difficulty in deciding what to emphasize at a university stems from the extraordinary diversity of human knowledge. It is impossible for one institution to cover it all. The broad brush decisions, such as whether to have a Department of Mathematics or a Faculty of Medicine may be easy, because some grasp of mathematics is central to a wide range of disciplines and professions and the province needs a medical school to train new physicians and otherwise serve the profession. It is also easy to see that there are some subjects of central importance in the provincial economy, such as natural resource management or Pacific Rim studies, for which university emphasis is geographically natural for British Columbia.

Beyond such obvious considerations, it is very much a matter of good judgment as to which fields will most command the attention of society in general and of the province in particular. For example, there is much current excitement about advanced materials science, biotechnology, artificial intelligence, superconductors, integrated computing systems, nuclear magnetic resonance imaging techniques, liposomes, remote sensing, and world changes in climate that could raise sea levels by six feet in the next fifty years. In which, if any, of these fields should which of the three provincial universities develop strength?

While there is no perfect wisdom on the subject, it is evident that the three universities will do better in the aggregate if there is sufficient consultation to ensure an optimal degree of complementarity. In many respects, the strategy of investment in advanced education must resemble that of a trust fund. A certain proportion of the portfolio should be invested in enterprises with a proven record of performance. Another proportion should be invested in a wide range of undertakings for which there is a certain measure of uncertainty about the long term future. In the aggregate the three universities, like three trust funds, should have much in common in the safe part of their portfolios and a healthy difference in the riskier part.

There is no single, simple, permanent recipe for ensuring that the universities are making the maximum possible contribution to the provincial economy other than to encourage a continuing dialogue within them, among them, and between them, the government and the various sectors of society. There is every reason to expect that just as the universities have played a key role in the past, they will play a key role in the new economy of the future, a role in keeping with the greater maturity and economic and social complexity of British Columbia.